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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
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| 09/782,185 | 02/12/2001 | Helen H. Zhu | LAM1P147/P0675 | 5391 |

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| EXAMINER | |
|---|---|
| CHEN, KIN CHAN | |
| ART UNIT | PAPER NUMBER |
| 1765 | 14 |

DATE MAILED: 05/21/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

| Office Action Summary | Application No. | Applicant(s) | |
|---|---|---|---|
| | 09/782,185 | ZHU ET AL. | |
| | Examiner | Art Unit | |
| | Kin-Chan Chen | 1765 | |

*-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --*

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1)☒ Responsive to communication(s) filed on *03 April 2003* .

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

4)☒ Claim(s) *19-37* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *19-37* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

**Application Papers**

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

**Priority under 35 U.S.C. §§ 119 and 120**

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

**Attachment(s)**

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) *12* .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

## DETAILED ACTION

### *Claim Rejections - 35 USC § 103*

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims 19-37 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tao et al. (US 6,194,128 B1) in view of Ye et al. (US 6,080,529).

Tao teaches a method for etching a feature in an integrated circuit wafer, the wafer incorporating at least one low-k dielectric layer partially disposed below a hardmask. Tao teaches that the wafer may be disposed within a reaction chamber. A flow of etchant gas comprising a fluorocarbon (such as $CHF_3$ or $CH_3F$) and an active etchant may be introduced into the reaction chamber (col. 3, lines 20-24; col. 7, lines 57-61). A plasma may be formed from the etchant gas within the reaction chamber and the feature with at least a portion of the low-k dielectric layer may be etched with the active etchant. Some of the hardmask may be sputtered with the active etchant (so-called etching the layer of low dielectric constant is performed in the MERIE in Tao, see col. 7, lines 57-58; col. 6, lines 25-28). Tao teaches that etchant gas may comprise fluorocarbon, nitrogen, and oxygen (col. 6, lines 38 to 45; col. 7, line 58). Unlike the claimed invention, Tao does not disclose that a volatile compound may be formed from

sputtered hardmask and fluorine and thus reducing micromasking. In a method for etching low k dielectrics, Ye teaches that the hydrogen/ nitrogen based plasma (such as ammonia; or hydrogen and nitrogen) may be used for etching low k dielectrics. The hydrogen/ nitrogen based plasma is especially useful for etching organic low-k dielectric in a multiplayer substrate (abstract; col. 6, lines 23-27 and 65-66; col. 7, lines 4-15). Hence, it would have been obvious to one with ordinary skill in the art to modify Tao by including hydrogen and / or ammonia plasma as active etchant as taught by Ye because Ye teaches that it is especially useful for etching organic low-k dielectric in a multiplayer substrate and because they are used for the same purpose of etching organic low-k dielectric. Therefore, a volatile compound is inherently formed from sputtered hardmask and fluorine and thus inherently contains same function (so-called reducing micromasking) because the same materials are used with the same process steps in the combined Tao and Ye.

" It is prima facie obvious to use two compositions (two methods) each of which is taught by the prior art to be useful for the same purpose. " In re Kerkhoven 205 USPQ 1069 (CCPA 1980). In re Susi 169 USPQ 423, 426 (CCPA 1971). See also Ex parte Quadranti 25 USPQ 2d 1071 (BPAI 1992).

The limitations of dependent claims 20, 21, 25, 28, 31, and 34 have been addressed above and rejected for the same reason, supra.

As to dependent claims 22, 26, and 27, Tao teaches the $CH_3F$ flow rate, which overlaps the claimed range (col. 6, lines 40-45). Ye teaches the flow rates of nitrogen and ammonia within the claimed range (col. 23, lines 30-37). Tao and Ye references are

relied on for the same reasons as stated, supra. Furthermore, the skilled artisan understands that in plasma etching, changing the flow rates of etchants changes the etching properties and etching selectivity (see Loewenstein (US 5,741,396); Silicon VLSI Technology (Plummer et al.) in the record as evidences). Therefore, it would have been obvious to one of ordinary skilled in the art to determine the suitable flow rates of etchants through routine experimentation in order to obtain the best-etched product achievable.

As to dependent claims 23, 24, 32, and 33, Tao is not particular about the low-k dielectric layer used in his process, therefore, it would be obvious to one skilled in the art to use an organic low-k dielectric layer (such as SILK, so-called silicon-free benzocyclobutene) because it is one of the well-known, most popular low-k dielectric layer in the art of semiconductor device fabrication. Ye is relied on to show this well-known feature (see col. 1, line 20; col. 23, lines 5-17). Hence, it would have been obvious to one with ordinary skill in the art to modify Tao by using this well-known organic low-k dielectric layer in order to provide their art recognized advantages and thus produce an expected result. Huang is also used as the evidence for the prior well-known feature statement. Huang teaches that the dielectric layer with low dielectric constant (low-k), such as Flare, SILK, and PAE-II are usually used to reduce interconnection parasitic capacitance, to reduce the RC delay and they are very popular IMD material.

As to dependent claims 29, 30, 35, and 36, because the same materials are used with the same process steps in the combined Tao and Ye, therefore, the process would

inherently deposit polymer from the fluorocarbon on the hardmask to reduce hardmask sputtering (claims 29 and 35), and on the sidewalls of the feature to reduce profile bowing (claims 30 and 36).

In reference to dependent claim 37, the discussion of modified Tao and Ye from above is repeated here. In addition, because the same materials are used with the same process steps in the combined Tao and Ye, therefore, the process would inherently sputtering some the hardmask during the etching an opening in the hardmask and forming a volatile compound during the etching an opening in the hardmask, wherein the active etchant etches the hardmask opening.

### *Response to Arguments*

3. Applicant's arguments filed April 3, 2003 have been fully considered but they are not persuasive.

Applicant has argued that Ye teach using hydrogen/ nitrogen based plasma for the α-FC layer not low-k organic dielectric. In fact, Ye teaches that the hydrogen/ nitrogen based plasma (such as ammonia; or hydrogen and nitrogen) may be used for etching low k dielectrics. The hydrogen/ nitrogen based plasma is especially useful for etching organic low-k dielectric in a multiplayer substrate (abstract; col. 6, lines 23-27 and 65-66; col. 7, lines 4-15). Hence, it would have been obvious to one with ordinary skill in the art to modify Tao by including hydrogen and / or ammonia plasma as active etchant as taught by Ye because Ye teaches that it is especially useful for etching

organic low-k dielectric in a multiplayer substrate and because they are used for the same purpose of etching organic low-k dielectric, also see the case law cited in the office action.

Applicant has argued that Ye teaches away from a fluorocarbon because Ye states that fluorine etchant tends to have a detrimental effect on a typical contact via or trench. It is not persuasive. Back to basic chemistry, fluorine gas and fluorocarbon are totally different chemicals with completely different properties. Furthermore, when prior art discloses the material having defect (detrimental effect), prior art does not have the kind of teaching that the material should not or cannot be used.

Applicant has argued that the combined prior art does not teach flow rates of etchant. As stated in the office action, the skilled artisan understands that in plasma etching, changing the flow rates of etchants changes the etching properties and etching selectivity (see Loewenstein (US 5,741,396); Silicon VLSI Technology (Plummer et al.) in the record as evidences). Therefore, it would have been obvious to one of ordinary skilled in the art to determine the suitable flow rates of etchants through routine experimentation in order to obtain the best-etched product achievable.

## ***Conclusion***

4. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Loewenstein (US 5,741,396) teaches that pressure, temperature, gas flow, and power may be varied for control of the etch selectivities (col. 7, lines 60

through col. 8, lines 12). Silicon VLSI Technology (Plummer et al., page 639): controlling gas composition and flow rate to achieve the desired etch properties.

**5. THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

6. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Kin-Chan Chen whose telephone number is (703) 305-0222. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Benjamin Utech can be reached on (703) 308-3836. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 872-9310 for regular communications and (703) 872-9311 for After Final communications. Any inquiry of a general nature or relating to the status of this

application or proceeding should be directed to the receptionist whose telephone number is (703) 308-2934.

K-C C
May 20, 2003

PRIMARY EXAMINER
ART UNIT 1765